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Evidence of mesospheric hydroxyl response to electron precipitation

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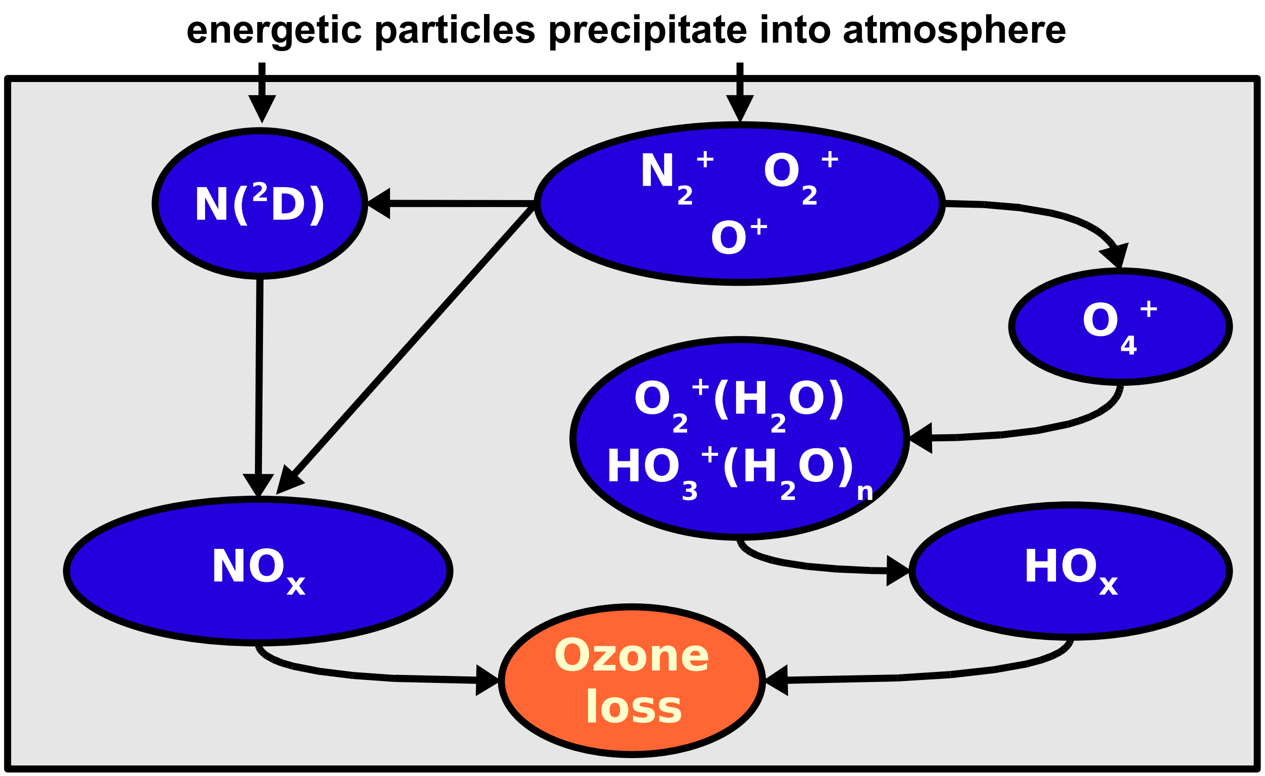
Effects of energetic particle precipitation (EPP)



Ozone connects to temperature and dynamics

Mesospheric odd hydrogen: indicator of EPP

- Night-time HO_x (= H + OH + HO_2) concentration is relatively low.
  $\Longrightarrow$ It can be enhanced by moderate EPP forcing.

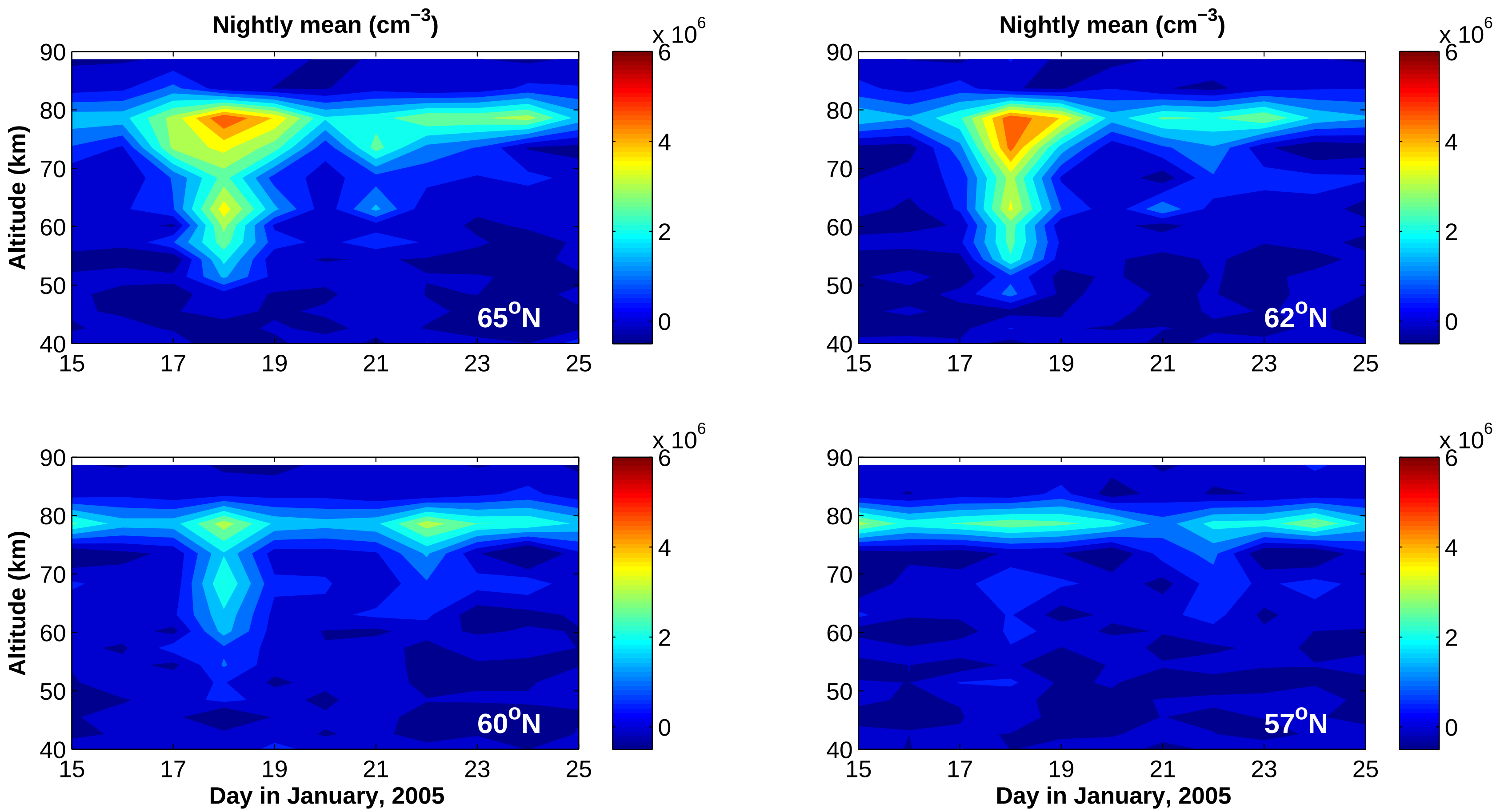
- HO_x has a relatively short chemical lifetime (hours) below $\approx$ 80 km.
  $\Longrightarrow$ Returns quickly to normal values after EPP forcing stops.

Odd hydrogen follows closely
increases and decreases of EPP forcing

- In the case of major solar proton events, HO_x increases are relatively easy to detect due to the large fluxes and polar cap coverage of the forcing.

MLS/Aura – mesospheric OH during EPP

Solar proton event of January 2005



Role of electron precipitation below 80 km

- Compared to solar proton events, electron precipitation typically has smaller fluxes, more temporal variability, and it affects more restricted latitude regions.

  $\Longrightarrow$ Electron flux observations are not always straight forward to use in atmospheric modeling.

  $\Longrightarrow$ It is not clear how big the direct effect of electron precipitation is in the lower mesosphere.

In the present work

- We study the connection between precipitating electrons (electron counts measured in the radiation belts by MEPED/POES) and mesospheric OH observed by MLS/Aura.

- We selected two cases, March 2005 and April 2006, because

  1) high electron count rates observed in the radiation belts, and

  2) no solar proton events occurred.

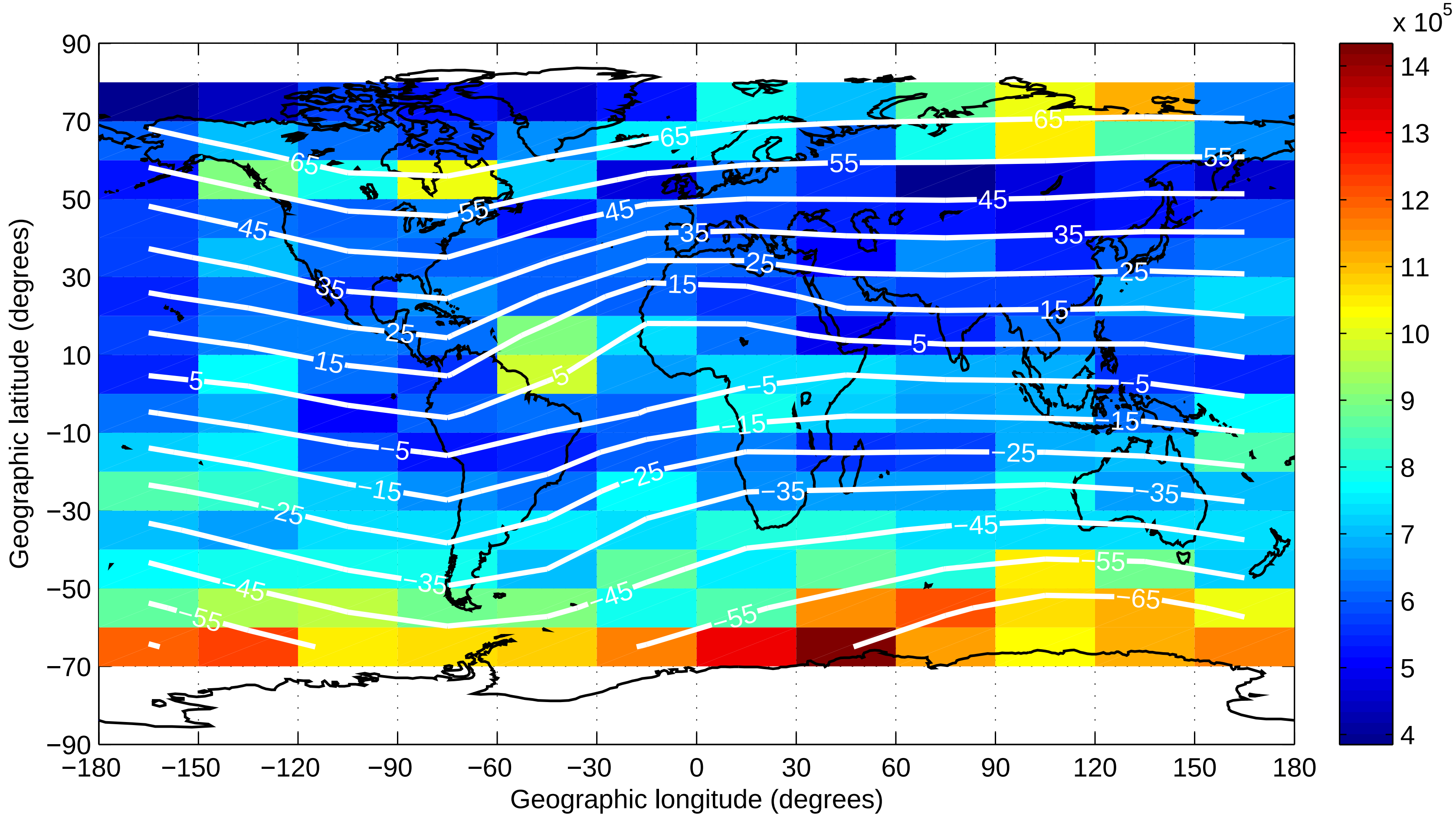
- We ask

  1) is electron precipitation causing measurable changes in OH?

  2) is it possible to use OH as a proxy for electron precipitation?

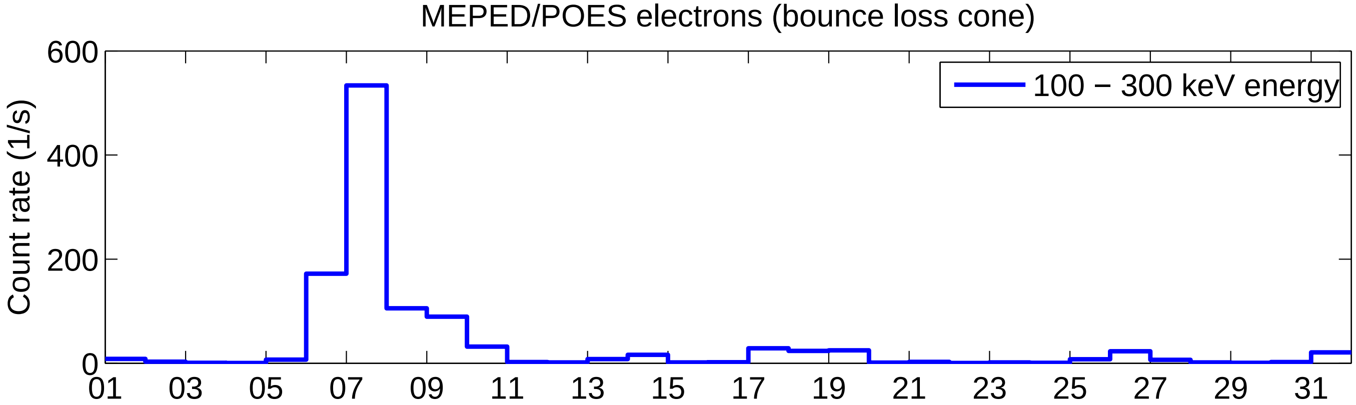
Mean night-time OH, March 5–10, 2005

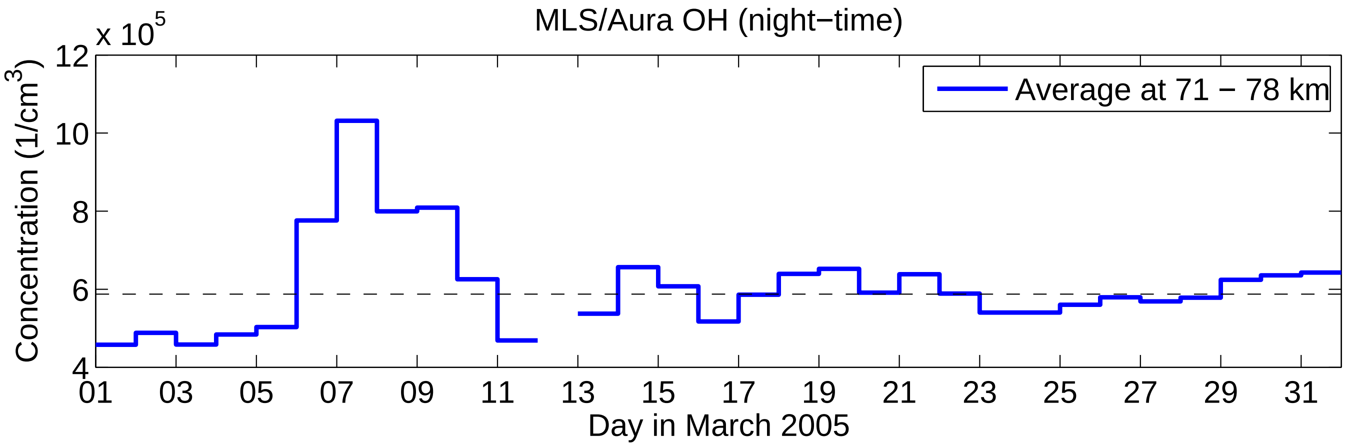
MLS/Aura, Altitudes 71 – 78 km, Units: cm^{-3}



Electron precipitation in March 2005

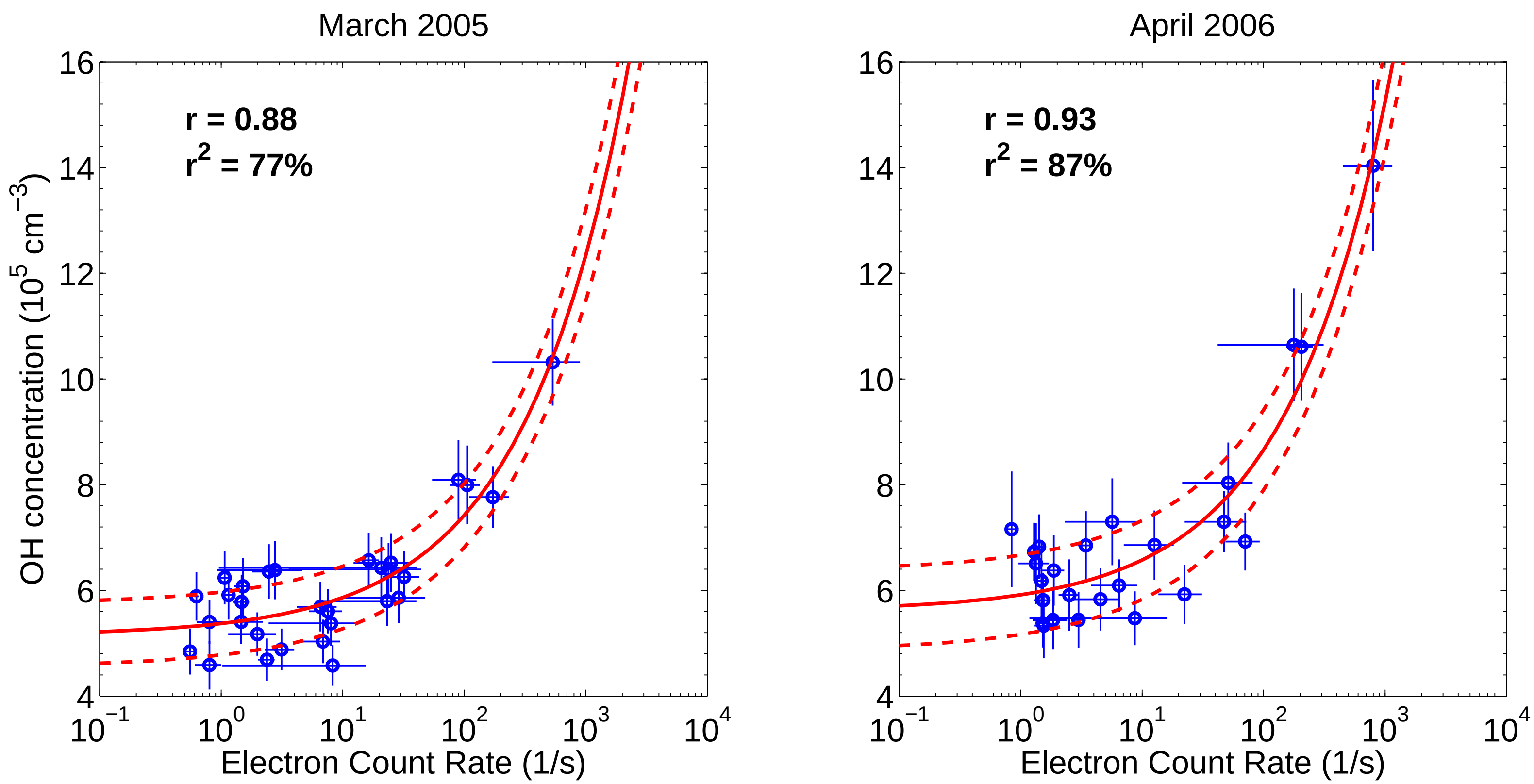
Magnetic latitudes 55 – 65°N





Electron count rate vs. OH concentration

Daily averages, magnetic latitudes 55 – 65°N



High electron count rates correspond to high OH concentrations!

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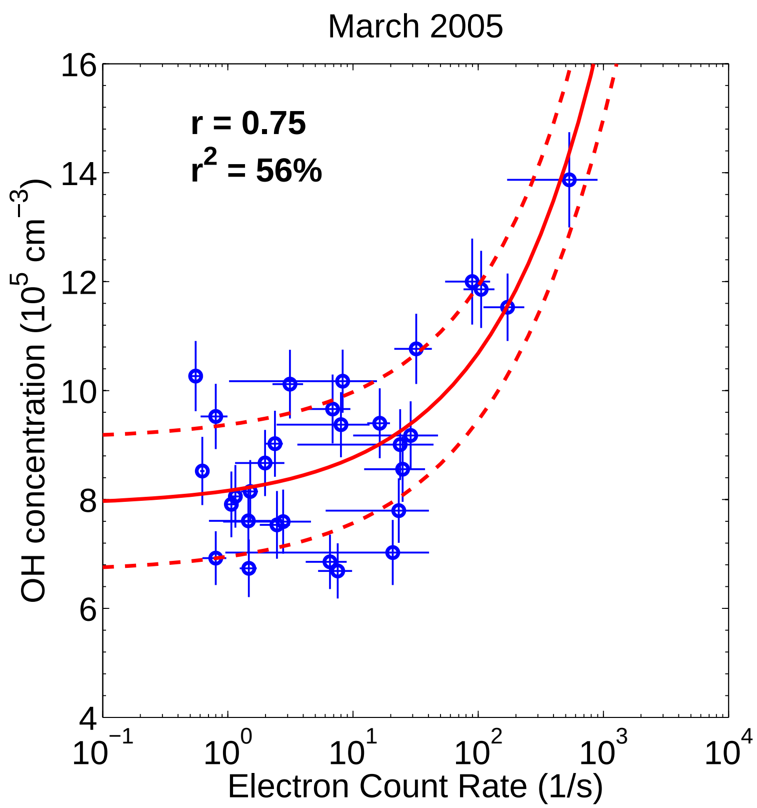
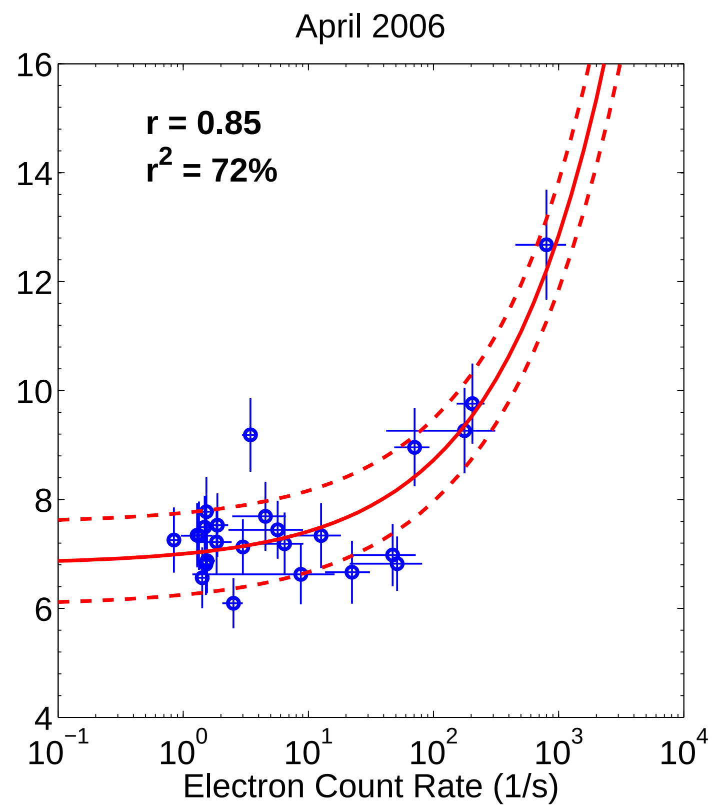
Electron count rate vs. OH concentration

Daily averages, magnetic latitudes 55 – 65°S





Higher background OH, higher electron flux threshold

Summary

- We have provided evidence of electron precipitation directly affecting mesopheric OH concentrations.
- In the two cases considered, high radiation belt electron count rates at 100 – 300 keV correspond to high OH concentrations at 71 – 78 km. Within the measured range of electron count rates, OH concentration increases by about 100%.
- 56 – 87% of the OH variation can be explained by electron precipitation. This percentage seems to depend on the background OH level, which affects the threshold flux of electrons.
- Based on this work, OH observations seem to be a good proxy for EEP. However, more work, data, and modelling are needed before stronger conclusions are made.